July 1972 B72-10335

NASA TECH BRIEF

Manned Spacecraft Center

Mathematical Techniques for Estimating Operational Readiness of Complex Systems

A report entitled "Mathematical Considerations of Operational Readiness" has been prepared as a guide for systems analysts. The report uses concepts from probability theory to develop methods of predicting operational readiness for a complex system. Use of the presented methods will aid engineers in the design of systems that offer an improved chance of mission accomplishment.

Operational readiness in this context is defined as the probability that a system can meet an operational objective during a prescribed interval of time, provided that some minimal maintenance can be carried out. The report introduces a well-known concept of the mean-time-between-failures or MTBF and presents an evaluation of its lower limit. Based on this lower limit which is estimated from the Chi-Square distribution, the designer can introduce an adequate number of spares to the system to improve its probability of operational success. The number of spares required is computed from the Poisson distribution.

The report includes a Poisson formulation for a parallel spare arrangement and expands to a more complex series-parallel configuration. The latter involves a system of linear, simultaneous, differential equations which are solved by the use of a Markov reliability matrix and Laplace transforms. Based on these operations, total system reliability is estimated. Maintenance probability, using the mean-time-to-repair (MTTR) concepts, and exponential distributions are also included in this report in addition to the expected number of failures in a given mission time.

In concluding the report, a hypothetical ground support equipment (GSE) subsystem is taken through the countdown sequences. The data used have been taken from actual GSE equipment, and the countdown time is given as 97 hours.

The report presents all the pertinent data for evaluation and shows the results of readiness probability computed by the above methods. All computations are performed by use of lower limits of MTBF's and upper limits of MTTR's.

Note:

Copies of this report may be obtained from:

Technology Utilization Officer
Manned Spacecraft Center
Code JM7
Houston, Texas 77058
Reference: TSP72-10335

Patent status:

No patent action is contemplated by NASA.

Source: Ives D. Jacquier and Paul A. Miltz of
North American Rockwell Corp.
under contract to
Manned Spacecraft Center
(MSC-17694)

Category 09